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WHITE RIVER SHALE PROJECT
SUPPLEMENTAL EXPLORATION PROPOSAL
TRACTS UA & UB

FEBRUARY, 1976

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WHITE RIVER SHALE PROJECT

SUPPLEMENTAL EXPLORATION PROPOSAL

TRACTS Ua & Ub

February, 1976

SUMMARY:

The proposal recommends drilling five additional surface holes on Tracts Ua and Ub, three of which will be vertical and two of which will be inclined about 30 degrees from vertical. Both rotary and core drilling will be employed and one vertical hole will be cored throughout to serve as a pilot hole for an initial access shaft. Completion of the proposal will provide additional ore reserve data and will allow a closer inspection of certain subsurface physical characteristics in areas that appear to be insufficiently explored. Thus, the new information will broaden the data base and improve the credibility of subsequent mine planning.

The proposal should be considered a logical extension of the Supplemental Geologic Exploration Program that was submitted in August, 1974. As such, the proposal will conform to the same environmental safeguards and follow similar operating procedures that were prescribed in the Supplemental Geologic Exploration Program and the subsequent conditions of approval that were attached to it.

Drill hole locations, hole depths, and placement of access roads are specifically recommended. Total drilling will amount to about 4,500 feet and as much as 3,200 feet of 2-1/2" diameter core will be cut. To improve efficiency, as compared to previous drilling, a wire line retrieval method will probably be used to remove core from the holes.

Completion of all five drill holes will require from six to ten weeks time, dependent on the amount of drilling equipment and the number of crews that will be assigned to the project. In general, the scale of the effort will be substantially less than the previous drilling program. As a consequence, impact on the on-going environmental base line activities is expected to be slight. Field work will start as soon as possible after receipt of the Oil Shale Supervisor's approval of the plan, or modifications thereof.

In addition to drilling, a subsequent gas monitoring program is recommended for certain drill holes. Information gathered will be used to predict the amount of gas influx that can be expected in an underground mine.

INTRODUCTION:

The following supplementary exploration plan is a logical step in the development of Tracts Ua and Ub. It will extend and equalize the amount of chemical and physical information that is available and that relates to the proposed mining zone. In fact, the Supplemental Geologic Exploration Program, which was completed early in 1975, stated that additional drilling would be proposed if additional mine design information was needed. Such a need has been demonstrated, mainly as a result of the widespread nature of previous drilling programs. The recommended program is designed to provide the needed information and, at the same time, stay within the existing environmental requirements.

DISCUSSION:

This supplemental program consists of five drill holes, two of which will be inclined. (Note Figure 1, page 21). The primary purpose for the two inclined holes will be to provide evidence relating to the occurrence of vertical fractures in or near the projected mining zone. They will also provide additional data pertaining to shale oil reserves as well as other physical and chemical characteristics. All five drill holes are positioned so as to equalize the exploratory coverage, thereby reducing the length of horizontal projections that have been made from existing widely spaced drill holes. (Note Figure 2, page 22).

As in the past, competent geotechnical personnel will be present to supervise the drilling activities, to coordinate and supervise appropriate logging and testing procedures at the drill

sites, and to prepare the core for sampling and additional testing elsewhere. During the coring phase particular emphasis will be placed on maintaining the physical integrity of the core as it is removed from the core barrel and placed in a rack for initial visual examination, detailed physical description, and measurement.

After completion of the supplemental program, two vertical holes (X-12 and X-16) will be equipped for gas monitoring, along with three holes from the previous drilling program (X-1, X-9 and X-11). At this time the remaining holes from both programs will be cleaned and plugged with cement to prevent vertical migration of fluids and possible pollution of existing aquifers. The gas monitoring wells will be plugged in a similar manner at the conclusion of the monitoring program.

Compared to past drilling that has been conducted on Tracts Ua and Ub, the proposed plan recommends smaller diameter core (2-1/2" as compared to 3 or 3-1/2"). This reduction in the size of the recovered material will permit the use of a wire line system of core retrieval. This method will improve efficiency and reduce the drilling cost, compared to previous drilling contracts. Whether a wire line system is used, however, will be dependent on the results of competitive bids to do the work.

Past experience in core drilling oil shale strongly suggests that a modest reduction in the size of core obtained will have little effect on total recovery, which is expected to remain high. Although smaller core will provide less material for sampling and testing, it will be an ample amount for this project.

Whenever possible, an air or air-mist system will be employed as the drilling medium, for both rotary and core drilling. However, wire line coring equipment will require the use of light drilling mud and the consequent need for portable tanks or small pits at the drill site.

The proposed plan is designed to make available additional information of a variable nature, most of which will be very helpful to the development of a reliable and comprehensive mine plan. As its several objectives indicate, the proposal represents a justifiable stage in the responsible development of the resource potential of Tracts Ua and Ub.

OBJECTIVES:

Following is a list of objectives for the proposed program:

1. Supplement available grade (gal/ton) and thickness data by closing gaps in the existing drill hole pattern, thereby reinforcing and increasing the reliability of existing ore reserve figures.

2. Provide additional subsurface structural information relating to such features as parting planes and steeply-dipping fractures. In particular, the two proposed inclined holes, widely spaced in an east-west direction and oriented perpendicular to what is believed to be the regional structural trend, will furnish useful information relating to the existence and frequency of occurrence of steeply-dipping, subsurface joints or fractures.

3. Provide a continuously cored investigative hole. The recovered core will permit a detailed examination (including tests, if necessary) to be made of the physical characteristics of the total column of rock that is penetrated.

4. Supply additional hydrocarbon gas measuring sites which will allow a more accurate determination to be made of the nature and dimensions of interstitial gas occurrences. Specifically, the program will offer an opportunity to monitor two new sources (X-12 and X-16) as soon as practicable after the mining zone has been penetrated. In addition to gas monitoring at the surface, plans include the measurement of gas emissions from selected core segments immediately upon retrieval. The technique involves enclosure of the rock specimen in an air-tight chamber equipped with a pressure gauge, followed by a series of time-related measurements.

5. Augment existing hydrologic data. Although no extensive monitoring program is included in the drilling proposal, periodic measurements of flow rates and conductivity will be made as the holes are drilled. The measurements will provide additional data relating to the character and extent of any aquifers that are present between the surface and the proposed mining zone.

DRILL HOLE SPECIFICATIONS:

Following is a list of parameters for the five proposed holes. Many of the figures are estimated but are expected to be near to the actual ones. Holes X-14 and X-15 are inclined, whereas the other three are vertically oriented.

CORE HOLE#	APPROX. DIST. FROM SOUTH SEC. LINE	APPROX. DIST. FROM WEST SEC. LINE	SEC., TP. & RANGE	GROUND ELEV.	MAHOGANY MARKER ELEV.	DEPTH TO MM	CORED INTERVAL	LENGTH OF CORE	TOTAL DEPTH
X-12	2,500 N	2,500 E	21, 10S, 24E	5,200	4,300	920	860-980	120	980
X-13	700 N	3,330 E	22, 10S, 24E	5,480	4,430	1,050	0-1150	1,150	1,150
X-14	2,100 N	2,850 E	24, 10S, 24E	5,150	4,680	470*	70-620*	550*	620*
X-15	2,900 N	2,300 E	20, 10S, 24E	5,250	4,200	1,220*	70-1290*	1,220*	1,290*
X-16	2,800 N	3,930 E	13, 10S, 24E	5,100	4,690	410	350-470	120	470
TOTALS								3,160	4,510

* Inclined distances.

Hole X-13 may act as an investigatory hole and will provide detailed physical data to guide subsequent development activities. As such, the hole will be cored throughout its length below the surface casing. To allow adequate time for hydrologic testing and analysis of the core, hole X-13 should be drilled first and completed as soon as practicable after the drilling program is started.

VERTICAL ROTARY AND CORE DRILLING:

Two of the proposed vertical holes (X-12 and X-16) will be cored through an approximate 120 foot interval extending from 60 feet above to 60 feet below the Mahogany marker. This interval, which extends beyond the upper and lower limits of the projected mining zone, is believed to be of sufficient extent to provide the needed data from the mining zone and adjacent zones above and below. The third vertical hole (X-13), in addition to being an infill exploratory hole, will serve as an investigatory hole for a proposed access shaft. To fulfill this role it will be cored continuously from the bottom of the alluvial zone. The initial 50 feet into bedrock will be cored first and then reamed to allow placement of surface casing. Subsequently, the remaining 1,100 feet will be cored and will provide useful information for shaft sinking.

DRILLING PROCEDURE - VERTICAL HOLES:

The following methods are suggested and are intended to be used as a general guide only. Actual field conditions may dictate that some variation in specifications and techniques will be required.

1. Position, level, and prepare rig for drilling.

2. Drill a 9" surface hole to a depth of 50 feet into bedrock.

3. Insert and cement 6-5/8" O.D. casing in the bottom of the hole.

4. Install blowout prevention device in top of casing and pressure test to 750 psi.

5. Connect water discharge (blooey) line and pressure relief line to rotating head and drill rig.

6. Drill cement out of casing with 5-5/8" rock bit and continue to drill to a point no less than 60 feet above the Mahogany marker.

7. Install Parshall flume to measure water flow rate when aquifer is intercepted. As drilling proceeds below the aquifer measure flow rate, conductivity, and temperature of water every 50 feet, or whenever significant changes in flow rate occur.

8. Collect continuous cuttings samples at 10-foot intervals and describe.

9. Attach a 3-7/8" swivel head and a 20 foot wire line (HC) core barrel and bit to core 120 foot section to a depth of 60 feet below the Mahogany marker. The core will be 2-1/2" in diameter.

10. Test for gas (H_2S and methane) every 50 feet while drilling.

11. Upon completion of drilling and removal of drill pipe, remove blowout prevention device and rotating head.

12. Attach protective cap to casing.

13. Run prescribed suite of geophysical logs.

14. Plug holes with cement or equip for gas monitoring as required.

INCLINED CORE DRILLING:

The proposal includes a provision for drilling two inclined core holes (X-14 and X-15). The sites for the two holes are located in the northwest corner of Tract Ua and in the southern part of Tract Ub (see Figure 1, page 21). Both locations are in areas in which existing holes are as much as 8,000 feet apart. Thus, the two inclined holes will fill some obvious gaps in the existing drill hole pattern.

In addition, the two inclined holes will permit acquisition of information from widely-spaced sources relating to the frequency of occurrence of steeply-dipping subsurface joints or fractures. Previous information obtained from vertical drill holes indicates that the subsurface material comprising the lower part of the Uinta formation and the Green River formation, at least down to the "B" groove, is very competent. Frequent parting planes parallel to bedding are present but steeply-dipping fractures are rare. However, core from vertical drill holes is an inherently poor source for determining the prevalence of steeply-dipping subsurface structural characteristics. As previous investigations did not include specific attempts designed to reveal the frequency of occurrence of near-vertical joints or fractures, the inclusion of two inclined holes in this supplemental program appears to be justified. Structural information obtained from these two holes will influence design parameters of an underground mine.

The problem of deviation in the slopes of inclined drill holes has been investigated. Discussions with experienced contractors indicate that the problem is minimal when drilling competent material. Liberal use

of stabilizers, immediately behind the bit, at the upper end of the core barrel, and farther up the drill string, effectively eliminates most of the tendency of the hole to deflect. It has been suggested, however, that inclined holes should be surveyed as they are drilled, at intervals of about 100 feet, so that hole deviation can be closely observed.

As stated, two inclined holes are recommended in this proposal. However, the estimated length of one hole is less than half the other (620 : 1,290 feet). To better acquaint ourselves with the extent of deviation in these circumstances, the shallower hole should be drilled first. Experience gained can be used advantageously to aid in completing the deeper one.

A minimum inclination of 30 degrees from vertical has been chosen for the inclined holes. This angle is believed to be adequate to intercept steeply-dipping physical features without requiring an excessive amount of additional drilled footage. The first hole will be aligned in a northeasterly direction (N30^{o}E), perpendicular to regional structural lineaments in the form of gilsonite-filled fissures that lie north and west of the tract boundaries. Recent surface structural investigations indicate that if steeply-dipping subsurface joints or fractures are present on Ua or Ub their most predominant direction is likely to be parallel to these fissures.

Physical evidence exhibited by core obtained from the first inclined hole (X-14) may suggest that the predominant direction of jointing is different from the indicated trend, or that a well

developed conjugate system of joints exists at or near the proposed mining zone. Either one or both of these circumstances may justify reorientation of the second inclined hole (X-15). In addition, a well-developed joint system near the mining zone may justify a down-hole, photographic log of the jointed interval.

The inclined holes will be cored throughout their length from the bottom of the surface casing. Rotary drilling to the zone of interest, as in the vertical holes, is not recommended due to the inability of maintaining a straight hole when drilling at an inclined angle with a conventional tricone bit.

DRILLING PROCEDURE - INCLINED HOLES:

As with vertical holes, the following procedures are suggested. Field conditions may require some variations.

1. Position, orient, and prepare rig for drilling.
2. Drill a 6" surface hole to a depth of 50 feet into bedrock.
3. Insert and cement 4-1/2" O.D. casing in the bottom of the hole.
4. Install blowout prevention device in top of casing and pressure test to 750 psi.
5. Connect water discharge (blooey) line and pressure relief lines to rotating head and drill rig.
6. Attach a 3-7/8" swivel head and a 20 foot wire line (HC) core barrel and bit.
7. Drill cement out of casing with a 3-7/8" diamond plug or core bit, and core drill throughout the remainder of the hole.

8. Install Parshall flume to measure water flow when aquifer is intercepted. As drilling proceeds below the aquifer measure flow rate, conductivity, and temperature of water every 50 feet, or whenever significant changes in flow rate occur.

9. Proceed as per steps #10 through #14 for vertical holes.

DRILL SITES AND ACCESS ROADS:

The recommended plan requires about 4-1/2 miles of road to provide access to the proposed drill hole sites (note Figure 1, page 21). However, much of this distance falls in the bottoms of gulleys and will require a minimal amount of surface disturbance to construct passable roadways. To reach the site of drill hole X-13 will require a considerable amount of road work throughout the final 0.3 mile. The site itself will require very little preparation.

In the instance of X-15, the drill site lies about one mile from the nearest existing road from which access can be gained with a minimum of difficulty. However, most of this distance falls in an existing gulley and only a modest amount of dozer work will be required to provide sufficient accessibility for a drill rig and other necessary vehicles. Some levelling will be required at the drill site. The initial Partial Geologic Exploration Plan did not include a hole in this area due to relative inaccessibility. However, the existing drill hole pattern is widely spaced near the northwest corner of Tract Ua (see Figure 2, page 22), and an in-fill hole is needed.

Access to X-12 can be gained by lightly dozing a 10-foot wide road along a small gulley for a distance of about 0.2 mile. Some levelling at the drill site will be required. Access to X-14 will be by an existing road in the bottom of a gulley and thence down Evacuation Creek. Little or no dozing will be required except for minor levelling at the drill site. For X-16, which lies adjacent to an existing road, no site preparation will be necessary.

Proposed drill sites and access roads will be subject to the approval of AOSS and BLM representatives. Alternate sites may be selected where necessary and applicable. However, as the drill holes, for the most part, are to provide information from specific areas of insufficient exploratory coverage, choices in site selection are more restricted than for previous drilling programs. Holes will best serve their intended purpose if they are drilled near the recommended locations. It should be emphasized that many of the previous drill hole locations were selected so as to minimize the amount of surface disturbance, as mentioned in the initial Partial Exploration Plan. Some sites were subsequently modified to reduce surface impact even more. The tendency was to avoid areas that were not easily accessible. This same minimal-impact philosophy has influenced the current supplemental drilling proposal. However, as investigatory goals become more specific, site selection becomes less flexible.

In conducting the drilling program the operator will not be allowed to block movement of public vehicular traffic or livestock.

Damage to public or private property in the area will be avoided. However, if such damage does occur and is judged to be the fault of the operator, compensation will be promptly made.

ENVIRONMENTAL PROTECTION PROCEDURES:

WASTE DISPOSAL:

1. Drill cuttings will be dispersed along roadways and around drill sites.

2. Garbage will be placed in appropriate containers and periodically collected and transported to a permissible dump or landfill.

3. Sewage will be controlled through the use of chemical toilets.

4. Subsurface water, whose conductivity is too high to allow release into the surface drainage system, will be impounded.

5. Vegetation that is removed in the construction of access roads and drill sites will either be stacked and burned or pulverized and used as a mulch in the revegetation efforts.

SURFACE RESTORATION:

Upon completion of drilling, sites will be cleared and, where applicable, topsoil will be replaced and the area will be planted with an appropriate mixture of seed. As one site (X-14) lies along Evacuation Creek and another site (X-13) is the proposed location of an access shaft, only three locations will require revegetative efforts initially. However, should subsequent development activities be delayed for a substantial period of time after completion of drilling, restorative work will be done at the X-13 drill site.

ARRANGEMENT OF SURFACE FACILITIES:

Plats will be drawn for each drill site on a scale of not less than one inch equals 100 feet. The sketches will show the approximate relationship between surface drilling facilities and the more prominent surface features.

ROCK CUTTINGS AND CORE EVALUATION:

During the rotary drilling phase of X-12 and X-16, cuttings will be collected at 10-foot intervals. Lithology will be described and lithologic changes will be noted. The information will be included in the final report.

A portion of the drill core from each hole will be split and assayed for oil yield, using the Modified Fischer Retort method. As was previously done, the core will be sawed through the zone of interest and samples representing 1-foot increments will be sent in for analysis. Comparable samples will be obtained from the core that is taken from the inclined holes. However, as the holes are inclined about 30 degrees from vertical, the core segment for each sample will be about 1.15 feet long.

Requirements for accessory minerals and trace element analyses have been satisfied by the completed Supplemental Geologic Exploration Program. For this reason the new Supplemental Drilling Program will not be required to supply more data of a similar nature. However, an additional series of trace element analyses has been requested and will be run on material taken from the "A" groove interval in hole X-13.

CORE DISPOSITION:

Subsequent to a lithologic description, measurement of percentage recovery, and description of various physical characteristics, the core will be properly labelled, wrapped in plastic (at least through the zone of interest), and boxed. It will then be shipped to the CCIC core storage warehouse and sampling facility in Rifle, Colorado. At that point the necessary representative samples for Fischer assaying, as well as any other test specimens that may be required, will be selected and prepared for shipment. The remaining cored material and rotary cuttings will be placed in storage in the Rifle warehouse along with that from previously drilled holes. It will remain there, subject to the client's judgement in regard to permanent future storage.

GEOPHYSICAL LOGGING:

A selected suite of geophysical logs will be run in each of the five drill holes. The actual techniques used will be very similar to those employed in the preceding Partial Exploration Plan that was completed last January. The list has been shortened somewhat and will include the following:

1. Density
2. Resistivity (self-potential)
3. 3-D Sonic
4. Caliper

In addition, two specialty logs (a kerogen analysis log and an elastic properties log) will be computer derived from the field data, as has been done with previous data from the "P" and "X" holes.

As in the past, a competent geophysicist will be responsible for this phase of the program. He will supervise the field work, and correlate and interpret the data which will result from the program.

ROCK MECHANICS:

A rock mechanics report will be submitted, covering the pertinent aspects of any additional physical rock characteristics, such as fractures, that may be revealed by the supplemental drilling program. However, no significant changes in physical rock properties are expected and it is not anticipated that an additional laboratory testing program will be required.

GEOLOGICAL REPORT:

A complete geological report will finalize the results of the drilling program. It will include detailed lithologic descriptions and enumeration of structural features noted in the cored material, coupled with Fischer assay results of all sampled intervals. In addition, it will contain information relating to groundwater characteristics and the location of key marker beds. The format will be similar to that used in the past, although some enhancement in lithologic detail is anticipated.

GAS MONITORING:

A program of hydrocarbon gas monitoring in selected drill holes is planned for Tracts Ua and Ub. In addition to two new holes (X-12 in Tract Ua and X-16 in Tract Ub) from which gas measurements will be taken shortly after penetration of the mining zone, the program will include holes X-1, X-9 and X-11 from previous drilling programs. Thus, four monitoring sites will be located in Tract Ua, where gas emissions appear to persist, and one site from Tract Ub, where little or no gas has been detected.

The dual objectives of the monitoring effort are to measure gas flow rates in the projected mining zone over an extended period of time and to make periodic surveys of bottom hole pressures. Attainment of the objectives will require isolation of the projected mining zone. This will be accomplished by placing and cementing casing in the drill holes, extending from the surface to the top of the zone. As the two new holes will be less than 4" in diameter through the cored interval (120 feet), they will be reamed to allow insertion of the casing. Prior to casing, these holes will be large enough to permit drill stem tests to be performed if needed.

The impermeable character of the kerogen-bearing Green River shales, in general, leads to the conclusion that the relatively minor gas flows that have been measured in several drill holes on Tracts Ua and Ub must be confined to thin zones of more permeable, mostly tuffaceous sandstone layers that are enclosed within the shale.

Visual observations made immediately after recovery of drill core from the "P" and "X" holes reinforce this opinion. These sandy layers occur abundantly in some zones in or near the projected mining interval. However, their vertical extent is very restricted and their permeability appears to be low.

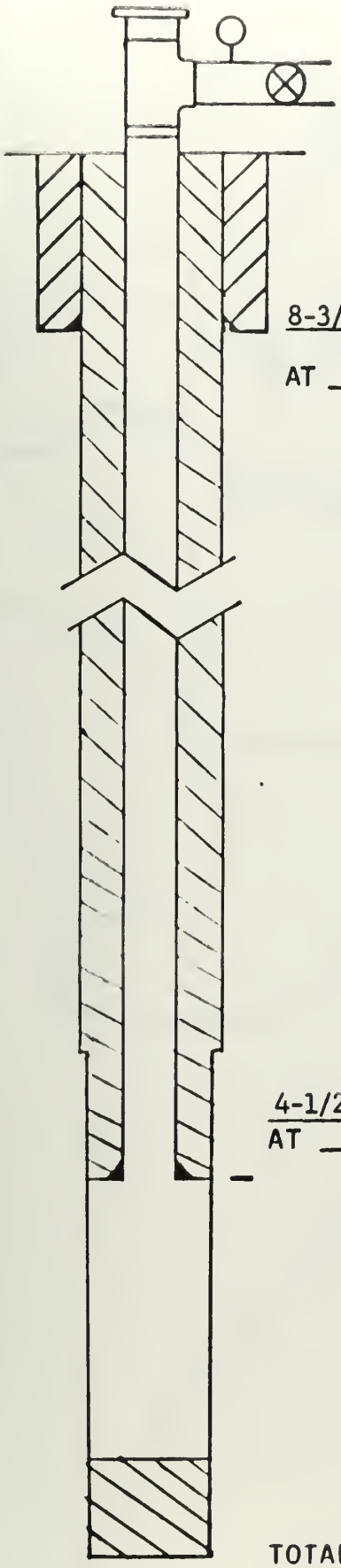
PROCEDURE:

The following steps are recommended as the best means of completing a well for gas monitoring:

1. Move in and set up double drum workover unit.
2. Run 2-3/8" tubing to plug back depth. Spot 3% calcium chloride cement from total depth to base of desired test interval. Pull out of hole.
3. Plug hole back with sand, from top of cement to top of test interval.
4. Run 4-1/2" casing with float shoe and set at top of desired test interval. Cement casing with volume required to circulate to surface. Tail in casing with 20 sacks of 3% calcium chloride cement. Allow cement to set.
5. Drill out float shoe and sand to base of desired test interval.
6. Go in hole with seating nipple and tubing to plug back depth. Swab fluid to total depth. Be prepared for minimum amount of gas flow.
7. Connect well for testing.

On the following page is a typical schematic diagram that illustrates, in cross section, the proposed method of well completion for gas monitoring.

WHITE RIVER SHALE PROJECT
GAS MONITOR WELL X-11
PROPOSED COMPLETION



		DEPTH	ELEVATION A.S.L.
SURFACE		0	5,261
8-3/4" CASING AT 80'			
FLUID LEVEL	8/7/75	423	4,838
4-1/2" O.D. CASING AT ___'			
MAHOGANY ZONE TOP		841	4,420
MAHOGANY MARKER		866	4,395
MAHOGANY ZONE BASE		943	4,318

TOTAL DEPTH 1,023'

CEMENT

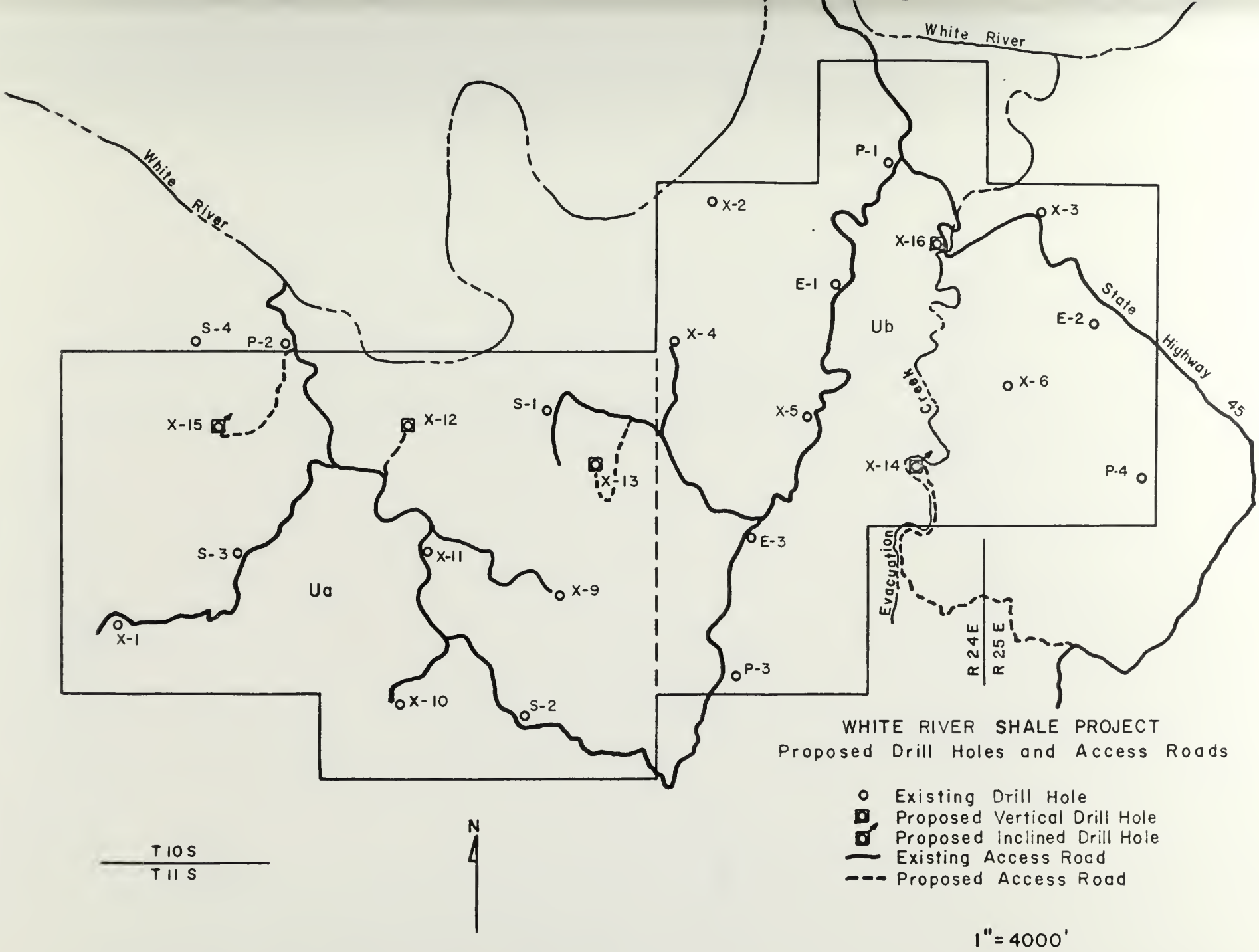
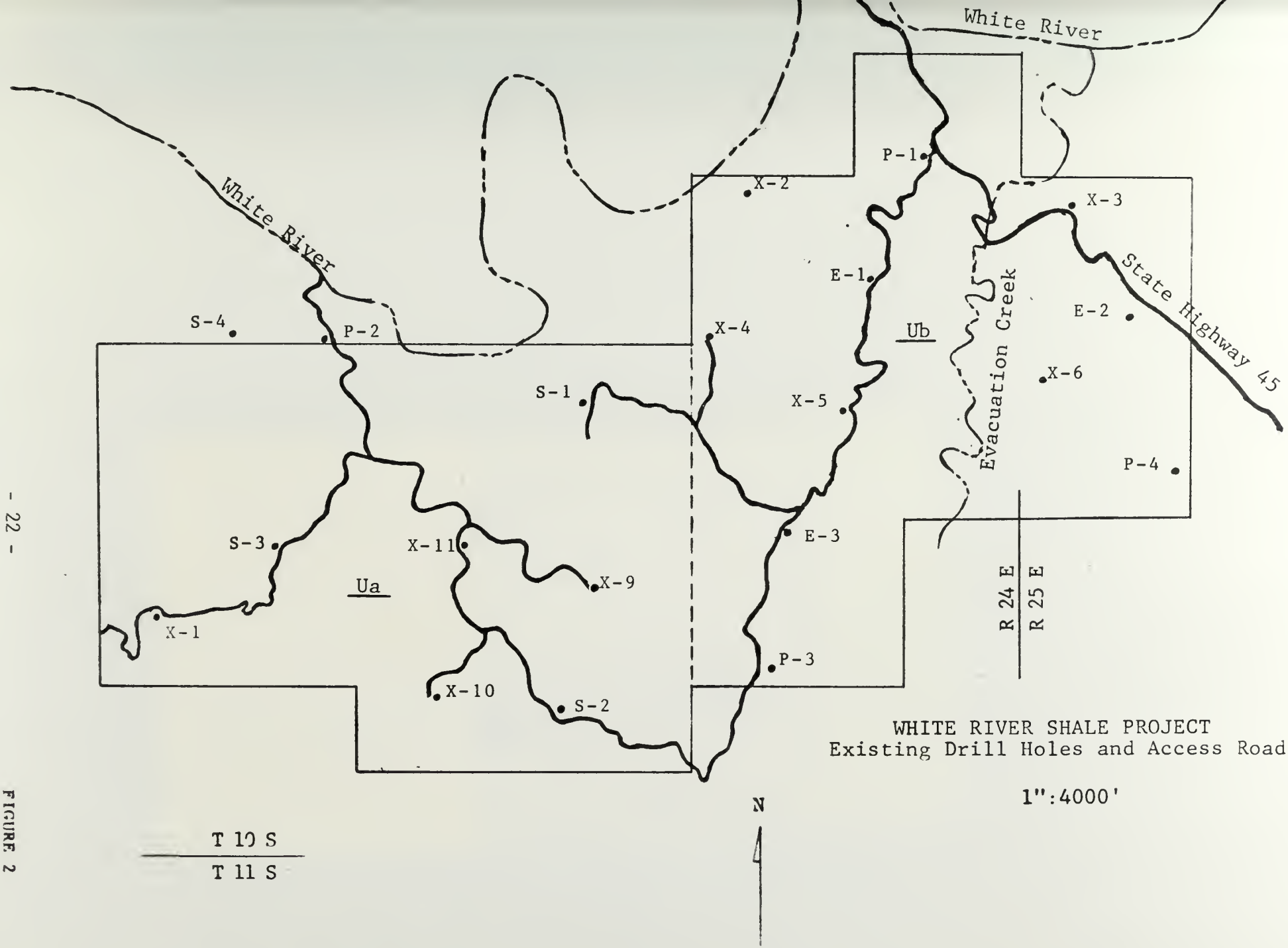

White River
White River
P-1
X-2
X-3
X-16
E-1
State Highway 45
E-2
Ub
X-4
S-4
P-2
X-6
Creek
X-5
S-1
X-12
X-15
X-13
X-14
P-4
E-3
S-3
X-11
X-9
Ua
Evacuation
X-1
R 24 E
R 25 E
P-3
X-10
S-2
T 10 S
T 11 S
N
WHITE RIVER SHALE PROJECT
Proposed Drill Holes and Access Roads
Existing Drill Hole
Proposed Vertical Drill Hole
Proposed Inclined Drill Hole
Existing Access Road
Proposed Access Road
1" = 4000'

FIGURE 1



WHITE RIVER SHALE PROJECT
Existing Drill Holes and Access Roads

1":4000'

FIGURE 2

ER'S CARD

4121 1976 c..

Shale Project
l exploration

	OFFICE	DATE RETURNED
NGER 701-789-13	UT-080	4/13/89

(Continued on reverse)